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Abstract: Rocks in the Ferguson Lake map area consist of multiply deformed Archean gneissic metavolcanic and metasedimentary rocks, and associated tonalitic, granitic, and gabbroic rocks, which have been metamorphosed to upper amphibolite facies. Variably deformed Proterozoic rocks include late gabbro, and syenite plutons and associated lamprophyre dykes. Massive sulphide mineralization is hosted along a stratigraphy-parallel hornblendite layer. Three generations of ductile structures are recognized (G_1, G_2, and G_3), where the development of the gneissic layering occurred prior to G_1 structures. The hornblendite records an S_1 foliation and it is, along with the massive sulphide mineralization, folded by F_2 and F_3. Since G_1 and G_2 events are tentatively correlated with 2.62 Ga thrusting and 2.55 Ga folding and metamorphism documented in the Yathkyed greenstone belt to the south, the hornblendite-hosted mineralization is inferred to be Archean.

Résumé : La région cartographique de Ferguson Lake renferme des roches métamorphiques gneissiques et polydéformées du faciès des amphibolites supérieur remontant à l'Archéen, qui sont formées de lithologies métavolcaniques et métasédimentaires, ainsi que de roches tonalitiques, granitiques et gabbroïques associées. Des roches plus ou moins déformées du Protérozoïque sont aussi présentes et se composent de gabbros tardifs, de plutons de syénite et de dykes de lamprophyre associés. Une minéralisation de sulfures massifs est contenue dans une couche de hornblendite concordante par rapport à la stratigraphie. Trois générations de structures ductiles (G_1, G_2 et G_3) ont été distinguées, là où la formation de la gneissosité est antérieure à celle des structures G_1. La couche de hornblendite conserve les traces d'une foliation S_1 qui, tout comme la minéralisation de sulfures massifs, est déformée par des plis P_2 et P_3. Puisque les épisodes de déformation G_1 et G_2 sont provisoirement corrélés à un épisode de chevauchement (2,62 Ga) et à un autre de plissement et de métamorphisme (2,55 Ga) dont les effets ont été documentés dans la ceinture de roches vertes de Yathkyed au sud, on conclut que la minéralisation encaissée dans la couche de hornblendite remonte à l'Archéen.

INTRODUCTION

During the 2003 field season, 1:20 000-scale bedrock mapping was carried out in the Ferguson Lake area, about 200 km west of Rankin Inlet, Nunavut. The project was initiated to provide a better understanding of the geology and deformation history of the Ferguson Lake area and to put the Ni-Cu-PGE deposit into a regional context. Ongoing geochemical and geochronological studies will further benefit the project. The presence of a Ni-Cu deposit at Ferguson Lake was identified by Inco in the early 1950s. Since acquiring the property in 1998, Starfield Resources Inc. has completed 62 000 m of diamond drilling and established an inferred resource of over 60 million tonnes at a 1% Ni-Cu cutoff (Pincock, Allen and Holt, unpub. internal report, 2003).

Previous geological mapping was conducted by Leggett et al. (1975) around the Ferguson Lake camp (1:30 000) and by Bell (1971) in the eastern part of the Ferguson Lake map area (NTS 65-I; 1:100 000), whereas Eade (1986) mapped the Tulemalu Lake–Yathkyed Lake area (NTS 65 J, I; 1:125 000). The study area joins to the south with previous mapping along the Yathkyed greenstone belt (Relf et al., 1997, 1998, 1999; 1:50 000 scale). The study area covers approximately 30 km^2 around Ferguson Lake (Fig. 1) and supplements previous internal company maps of the area (e.g. M. Henderson, unpub. report, 1999; L. Gal, unpub. internal memo, Starfield Resources Inc., September 2001).

GEOLOGICAL SETTING

The map area lies within the Hearne Domain of the western Churchill Province, and constitutes the northernmost extension of the Yathkyed greenstone belt (Fig. 1). It is underlain by strongly foliated and lineated, to locally gneissic Archean supracrustal and intrusive rocks metamorphosed to upper amphibolite facies, as well as variably deformed Proterozoic plutons and dykes. Gneissic layering, in large part defined by injected sheets and veins of monzogranite, is most intense in the central part of the map area, and protoliths can only be determined in the north and south. The Ferguson Lake massive sulphide body outcrops along an east-west band across the central part of the map area (Fig. 1) and is hosted by a hornblendite layer within hornblende diorite.

MAP UNITS

Rocks exposed in the map area exhibit a pervasive gneissosity and/or foliation and everywhere have been strongly deformed. Thus, assignment of appropriate protoliths is typically challenging. The units described below are subdivided into rocks that are demonstrably metamorphosed supracrustal rocks, and metamorphic rocks with an intrusive or, in some cases, uncertain protolith. For simplicity, we have dropped the prefix meta in the following descriptions.

Metamorphosed supracrustal rocks

Mixed volcanic rocks (unit 1)

Mixed volcanic rocks include bedded tuffs, massive flows, and locally pillowed flows. This unit displays centimetre-scale layers of fine-grained hornblende, chlorite±garnet-bearing rocks metamorphosed to amphibolite facies grade. The mafic volcanic rocks commonly show thin compositional layering interpreted to represent highly strained and transposed bedding. Amygdaloidal basalt with calcite-filled amygdales is locally preserved. Rare remnants of pillow selvages have been identified, although no unambiguous younging directions could be determined. The mafic layers are locally interbedded with felsic volcaniclastic intervals (Fig. 2A) that are strongly deformed, exhibit a penetrative foliation or lineation and are locally mylonitized. These lithologies are commonly intruded by monzogranite sheets and veins that are also mylonitized.

Finely banded magnetite-bearing siliceous units, locally associated with the intermediate to felsic volcanic rocks (unit 1), but also observed interbedded with sedimentary rocks (unit *2*), were recognized and inferred to represent iron-formation. These are typically garnet-rich, range from several centimetres to a few metres thick, and have a gossanous surface expression.

Psammite (unit 2)

Rocks of unambiguous sedimentary origin outcrop in the southern portion of the map area (Fig. 1) and are continuous along strike with psammitic units mapped by Relf et al. (1999). The rocks are thickly bedded (centimetre to decimetre scale) and are partly migmatized. Although bedding can be locally observed, no convincing younging directions were determined. Where migmatized, the psammite contained up to 40% quartzofeldspathic (?melt) segregations, along with aluminosilicate phases such as biotite, cordierite, and locally garnet (Fig. 2B). Garnet porphyroblasts are typically replaced by cordierite.

Hornblende biotite gneissic tonalite (unit 3)

Hornblende- and biotite-bearing gneissic tonalite is locally interlayered with hornblende diorite. Contacts with the psammitic unit (unit 2) everywhere appears gradational, and this unit is interpreted as a migmatized and metamorphosed psammite having interlayered mafic volcanic horizons. The gneissic tonalite is distinguished from the gneissic biotite tonalite (unit 7) by the presence of hornblende.

Intrusive rocks

Mixed unit (unit 4)

This has been informally termed the 'mixed unit' as it contains numerous interlayered lithologies such as hornblende diorite, hornblende biotite tonalite, hornblendite, and

106-03729/

abundant monzogranitic to tonalitic sheets and veins (Fig. 2C). The relative proportion of each unit is variable, and locally monzogranite sheets comprise over 50% of the exposures.

Hornblende diorite within the 'mixed unit' is fine grained, generally gneissic to strongly lineated, and contains up to 50% plagioclase with less common biotite and garnet. Similarly, the hornblende biotite tonalite is gneissic to foliated, and the proportion of hornblende versus biotite is variable. Concentration of biotite within specific layers is locally accompanied by the appearance of garnet and cordierite.

The monzogranite sheets are generally a few centimetres to several metres thick and intrude all of the units described above. Their composition varies from monzogranite to less abundant tonalite. They are coarse grained to pegmatitic and locally contain garnet and muscovite. These sheets were generally intruded parallel to the stratigraphy and define the main

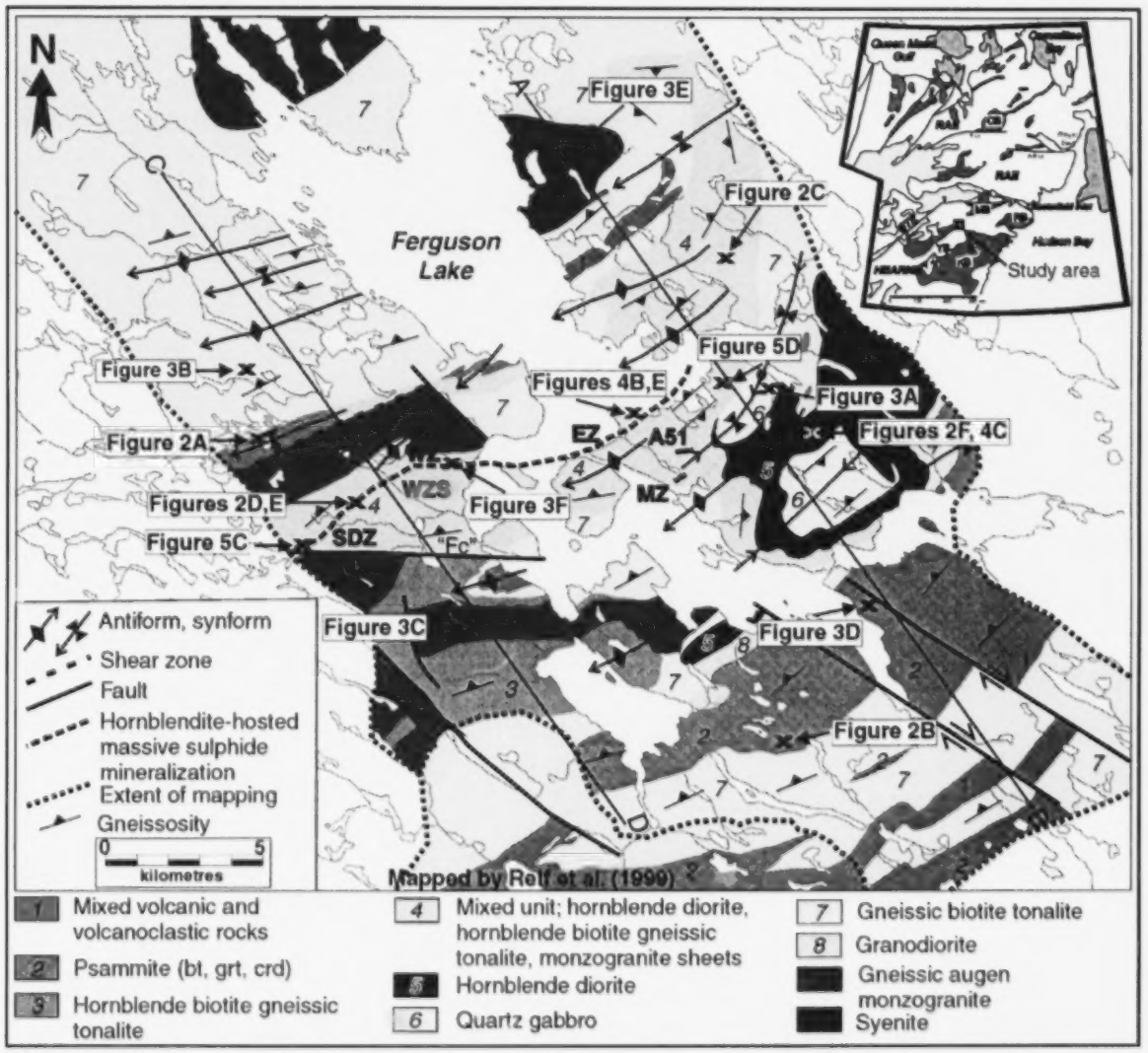

Figure 1. *Simplified geological map of the Ferguson Lake area. WZ, West zone; EZ, east zone; WZS, West zone south; A51, Anomaly 51; SDZ, South Discovery zone; MZ, M zone. Locations of photographs discussed in the text are indicated on the map. Inset in the upper right corner shows the location of the study area within the western Churchill Province. YB, Yathkyed greenstone belt; KB, Kaminak greenstone belt; MB, MacQuoid greenstone belt; RB, Rankin greenstone belt; CB, Committee Bay greenstone belt; STZ, Snowbird tectonic zone; WBsz, Wager Bay shear zone; Asz, Amer shear zone.*

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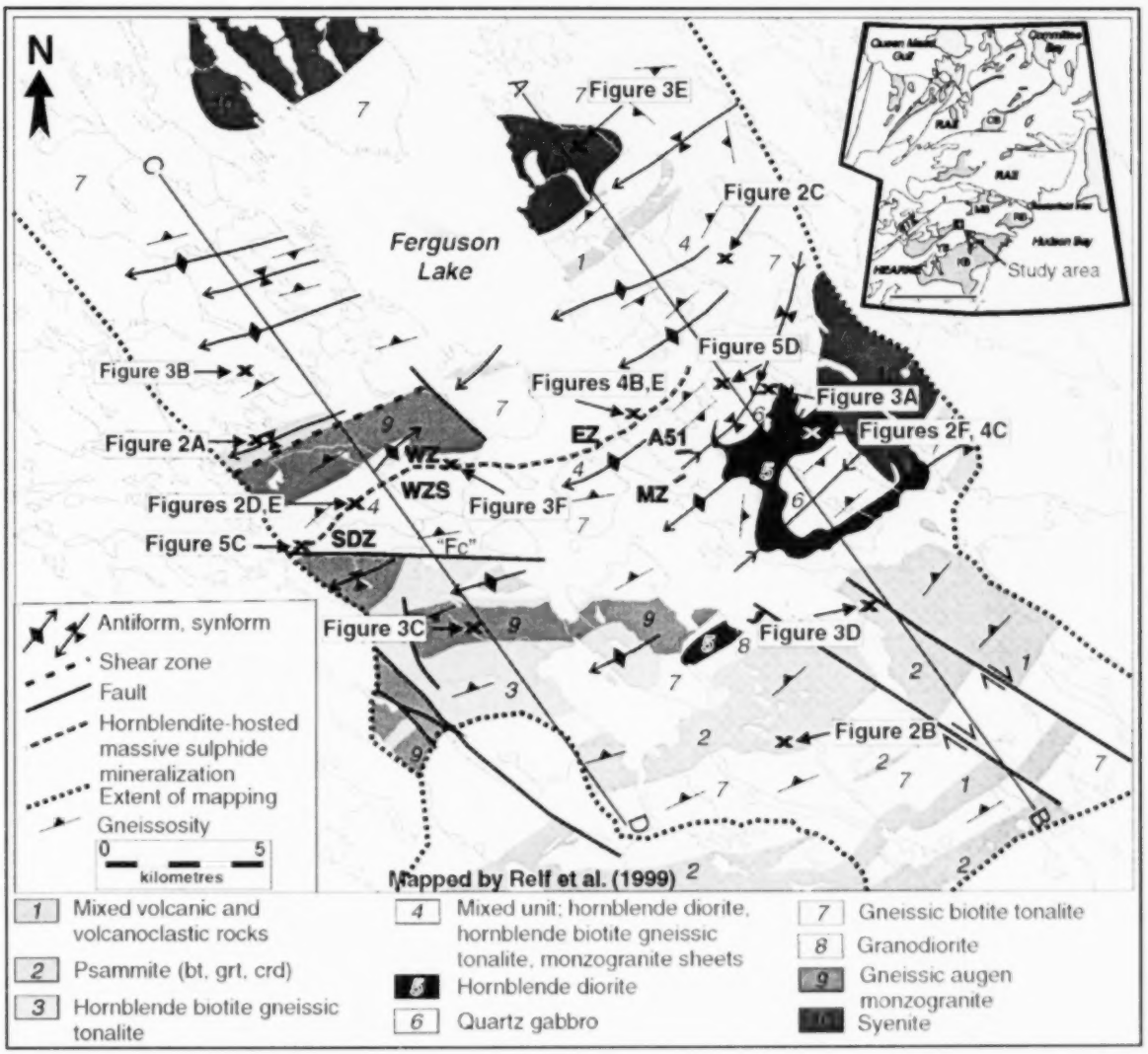

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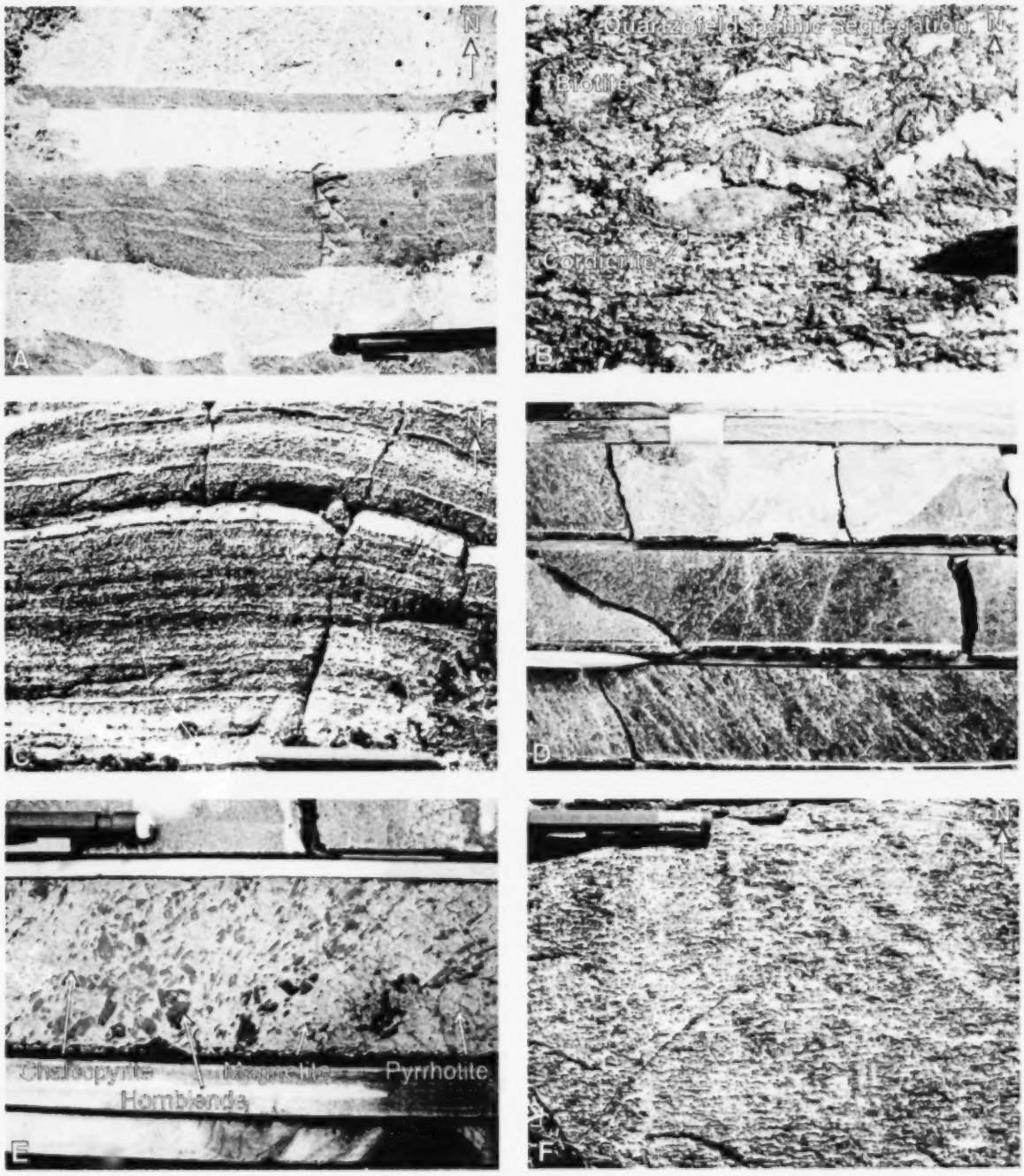

Figure 2. *A) Mafic volcanic horizons interbedded with felsic lapilli tuff and comprising part of the mixed volcanic unit (unit 1); portion of pencil shown is 11 cm.* **B)** *Cordierite-garnet-biotite-quartzofeldspathic segregation-bearing psammite (unit 2); portion of pencil shown is 2 cm.* **C)** *Interlayered hornblende diorite and hornblende-biotite gneissic tonalite, intruded by monzogranite veins and/or sheets (unit 4); marker shown is 13.5 cm.* **D)** *Coarse-grained, foliated hornblendite (unit 4) that hosts the massive sulphide mineralization; portion of pencil shown is 5.5 cm.* **E)** *Massive sulphide mineralization in drill core with aligned hornblende grains; portion of pencil shown is 4.5 cm.* **F)** *Hornblende diorite (unit 5) that is locally garnet-bearing. Note the well developed, subhorizontal mineral lineation defined by hornblende; portion of pencil shown is 5.5 cm.*

gneissic fabric. Some pegmatitic monzogranite intrusions cut the main gneissosity (S_{gn}) and are interpreted as younger intrusive phases.

Hornblendite (Fig. 2D) occurs as a layer (interpreted as a sill, *see* below) within hornblende diorite, and can be up to 75 m thick. The hornblendite is composed of medium- to coarse-grained hornblende with less than 10% plagioclase, and small amounts of biotite and/or chlorite. The hornblendite may appear much less deformed than the surrounding rocks, but hornblende grains are commonly preferentially aligned yielding a spaced and irregular foliation also defined by 'schlieren' of mica (?sericite, Fig. 2D). This foliation (interpreted as S_1; *see* below) is transposed and folded. Hornblendite is always observed in association with hornblende diorite and invariably hosts the massive sulphide mineralization (Fig. 2E).

The massive sulphide interval consists of 80–90% massive to semimassive pyrrhotite, with lesser amounts of magnetite and chalcopyrite. Pentlandite is common as an exsolution phase in pyrrhotite and rare moncheite (Pt, Pd) (Te, Bi) and gersdorffit (Co-sulphide) have been identified (J.F. Harris, internal report Starfield Resources Inc., 2000). Clasts of the host rock are common throughout the massive sulphide interval and consist of hornblendite, hornblende diorite, and less common garnet, feldspar, biotite, chlorite, and quartz grains. The clasts range from a few millimetres to several centimetres, are subangular, and locally aligned parallel to the main fabric. The greatest thickness (45 m) of massive sulphide has been intersected in the central part of the 'West zone' (Starfield Resources Inc., DDH-FL00-84). In addition, a poorly defined, low-sulphide, PGE-rich interval has been identified structurally below the massive sulphide horizon within the hornblende-biotite tonalite.

Collectively all rocks of unit 4 are strongly deformed and intruded by monzogranite sheets. The hornblendite hosting the massive sulphide interval is spatially associated with hornblende diorite and hornblende-biotite tonalite and exhibits gradational contacts with both lithologies. Unit 4 has a fairly sharp contact with unit 9 (*see* below), which forms the structural hanging wall to the mineralization. Based on the metal association and the nature of the contacts, the protolith is interpreted as a multiphase or differentiated intrusive body.

Hornblende diorite (unit 5)

The hornblende diorite (±biotite and garnet) is strongly lineated and weakly gneissic (Fig. 2F) and is locally interlayered with fine-grained tonalitic rocks that contain quartz and biotite±garnet±cordierite. It is interpreted as an amphibolitized intrusive body, but may possibly represent amphibolitized mafic volcanic rocks interlayered with less abundant, strongly migmatized psammite.

Quartz-gabbro (unit 6)

The quartz-gabbro is a distinctive unit composed mainly of plagioclase and hornblende (≤80% plagioclase) and lesser amounts of quartz, garnet, and epidote. The rock is variably strained, ranging from coarse undeformed and rounded plagioclase floating in a matrix of hornblende (Fig. 3A), to highly foliated and lineated, fine-grained plagioclase with hornblende aligned parallel to the main foliation or lineation. Where highly strained, the quartz gabbro can be mistaken for medium-grained hornblende diorite (unit 5). Disseminated pyrrhotite±chalcopyrite mineralization is locally present in this unit.

Gneissic biotite tonalite (unit 7)

Biotite tonalite is gneissic to foliated (Fig. 3B) and generally leucocratic, depending on the amount of biotite (up to 25%). It commonly contains decimetre- to metre-scale inclusions of hornblende diorite which are foliated to gneissic and are flattened parallel to the main fabric. The gneissic layering is centimetre to decimetre in scale and commonly accentuated by coarse-grained to pegmatitic monzogranite sheets up to 50 m thick. These sheets were intruded parallel to the gneissosity (forming an injection gneiss) and commonly outline major folds. In the south of the map area, monzogranite sheets locally contain accessory minerals such as muscovite and garnet and, on this basis, are interpreted as products of partial melting of aluminous crustal protoliths. This unit is folded along with the supracrustal rocks, suggesting that it was emplaced relatively early in the geological history of the area.

Granodiorite (unit 8)

This unit includes all rocks with an overall granodiorite composition. It varies widely in composition from tonalite through predominant granodiorite to less common monzogranite, all of which are characterized by abundant injected monzogranite sheets. Hence, some rocks are likely tonalite, with a higher than normal proportion of potassium feldspar crystals resulting from disaggregation and shearing of the abundant monzogranite sheets and veins. This unit also includes younger pegmatitic granite (e.g. south of the 'West zone').

Gneissic 'augen' monzogranite (unit 9)

The 'augen' monzogranite is readily distinguished in the field and in drill core as it contains centimetre- to decimetre-scale potassium feldspar porphyroclasts (Fig. 3C). It is commonly interlayered with bands of melanocratic, biotite-rich tonalite and/or hornblende diorite. The 'augen' monzogranite is highly strained, gneissic to strongly foliated (protomylonite), with feldspar porphyroclasts that acted as rigid grains around which the quartz was strongly flattened to form quartz ribbons. The northern contact of the 'augen' monzogranite with rocks of unit 1 is defined by a high-strain zone within which the protolith is uncertain. This highly strained unit has been previously termed a "leucitite" by M. Henderson (unpub. report, 1999) and consists of feldspar porphyroclasts (?clasts) within a mica-rich, fine-grained matrix. The contact with the adjacent 'mixed unit' (unit 4) is sharp, locally defined by a 10–20 cm wide biotite-rich schistose zone. The 'augen' monzogranite has a sharp contact with the structurally underlying 'mixed unit', suggesting it is intrusive.

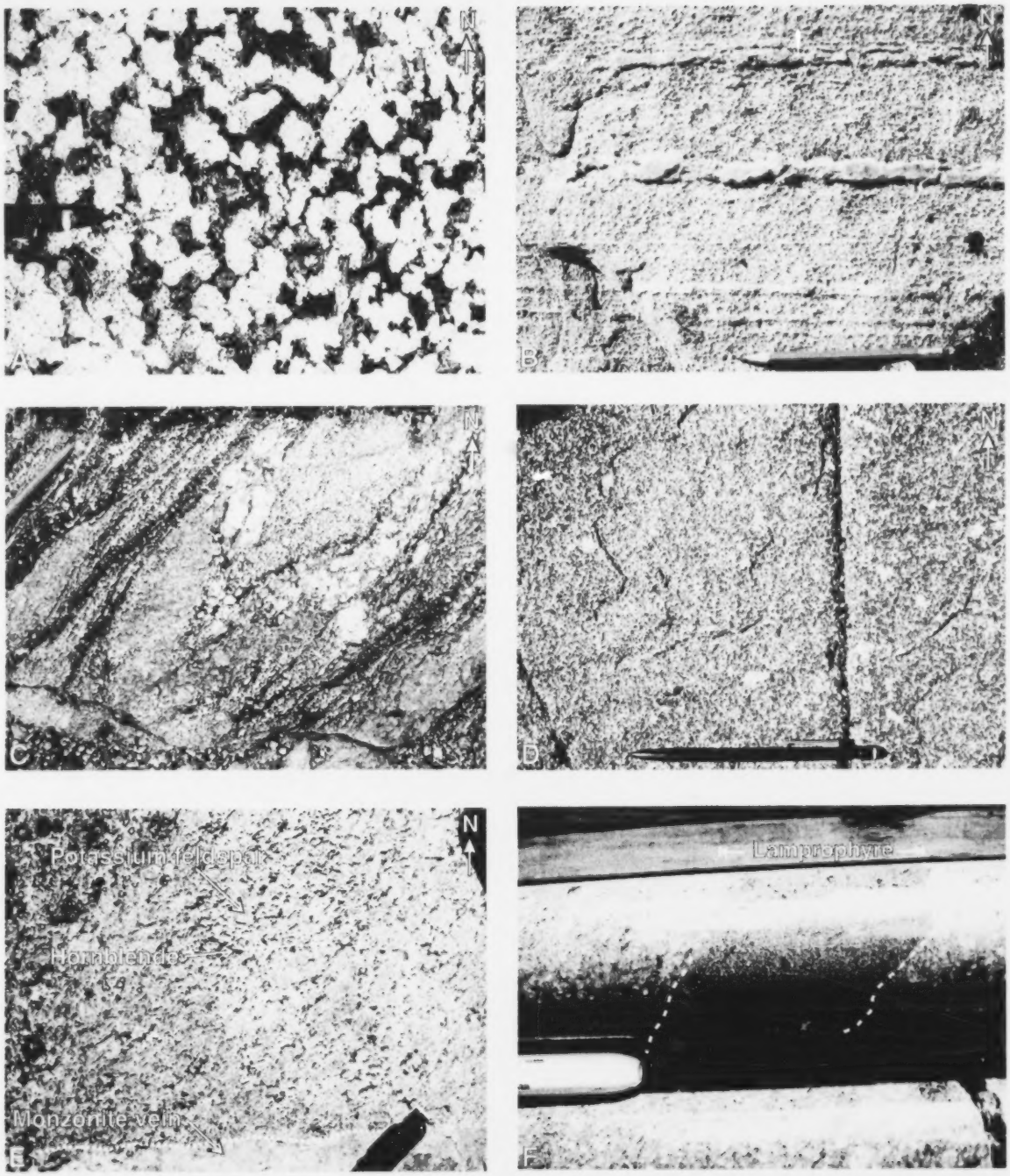

Figure 3. A) *Plagioclase glomeroporphyritic quartz gabbro (unit 6); portion of pencil shown is 3 cm.* ***B)*** *Gneissic biotite tonalite with injections of monzogranite (unit 7); pencil shown is 14 cm.* ***C)*** *Gneissic 'augen' monzogranite (unit 9) interbanded with hornblende diorite; portion of marker shown is 10 cm.* ***D)*** *Fine-grained gabbro dyke (correlative with the Tulemalu swarm) with dispersed, anhedral plagioclase phenocrysts; pencil shown is 15 cm.* ***E)*** *Coarse-grained and foliated hornblende-bearing syenite (unit 10) cut by fine-grained monzonite veins. Note that the potassium feldspar grains are preferentially aligned (parallel to the marker); portion of marker shown is 5.5 cm.* ***F)*** *Quartz-feldspar porphyry dyke cut by a phlogopite-bearing lamprophyre dyke; portion of marker shown is 3.5 cm.*

Late gabbroic intrusions

Fine- to medium-grained gabbro occurs as dykes, sills, and irregular bodies throughout the region (Fig. 3F). The gabbro is generally massive, but commonly exhibits foliated margins, and discrete shear zones locally occur within the intrusions. The gabbroic intrusions can be up to 50 m wide and generally cut the regional gneissosity (S_{gn}) at a low angle. The dykes vary in orientation, but are predominantly oriented east-west and north-south. They are generally weakly magnetic, but some were strongly magnetic, particularly in the southwestern corner of the map area. Some dykes contain centimetre-scale zoned plagioclase phenocrysts (Fig. 3D). These gabbros are interpreted to be part of the Tulemalu-MacQuoid dyke swarm dated at ca. 2.19 (U/Pb baddeleyite; Tella et al. (1997)).

Alkaline intrusive rocks (unit 10)

Alkaline intrusions include syenite plutons, monzonite and quartz-syenite veins and dykes, and abundant lamprophyre dykes. Ovoid syenite plutons range up to 5 km in diameter (Fig. 1), and typically contain abundant equant potassium feldspar phenocrysts with subordinate hornblende, biotite, pyroxene, and magnetite phenocrysts (Fig. 3E). Multiple intrusive phases were observed, varying from fine- to coarse-grained, and from alkali-feldspar-dominated to phlogopite- and/or hornblende-rich. A mafic phase of one of the plutons exposed in the northern part of the map area (Fig. 1) appears to be composed mainly of hornblende (possibly after pyroxene) and clinopyroxene. This mafic intrusive phase of the syenite is cut by a 7 m wide gabbro dyke with chilled and locally foliated margins. This syenite is locally foliated, the foliation defined by aligned feldspar phenocrysts (Fig. 3E) and less commonly by hornblende or biotite. A mineral lineation defined by hornblende was also observed at one locality. The syenite bodies are correlated with the Martell plutonic suite (ca. 1.83 Ga; Sandeman et al. (2000) and references therein).

Lamprophyre dykes, also abundant in the map area, range from phlogopite-rich mafic to phlogopite-poor felsic varieties and typically consist of a fine-grained feldspathic matrix with phlogopite, hornblende, and clinopyroxene phenocrysts (Fig. 3F). The dykes are somewhat randomly oriented, but most commonly trend northeast. They vary from centimetre- to metre-scale; the largest dyke mapped having a thickness of about 15 m. Where the matrix was coarse enough to identify individual grains, the dykes were classified as phlogopite syenite, some of which contain millimetre-scale spheroidal quartz grains. These syenite dykes cut the regional foliation and were locally observed to cut mafic lamprophyre dykes. Felsic varieties are likely cogenetic with the coarse-grained syenite plutons that outcrop in the area, whereas mafic lamprophyre dykes are inferred to correlate with the Christopher Island Formation of the Baker Lake Basin (ca. 1.83 Ga: Tella et al. (1985); Roddick and Miller (1994); MacRae et al. (1996)).

Quartz-feldspar porphyry dykes

A number of quartz-feldspar porphyry dykes (Fig. 3E) were observed both on surface and in drill core. These fine- to medium-grained dykes are generally massive but are locally foliated along their margins and have been observed to cut the massive sulphide interval.

STRUCTURAL ELEMENTS

At least three generations of ductile deformation (G_1, G_2, and G_3) were followed by late ductile and/or brittle shearing and brittle faulting. The term G (generation) is used here (as opposed to D = deformation) to describe the generation of ductile fabrics as the timing of deformation is not well constrained, and more than one generation of structures may have developed during a single deformation event.

Gneissosity (S_{gn})

The earliest fabric recognized to overprint bedding is the gneissosity (S_{gn}, Fig. 4A), which is developed in most of the rocks of the map area. Whether S_{gn} developed during the early stages of G_1, or represents a pre-G_1 fabric is uncertain, but we infer that it likely developed prior to G_1, as the S_{gn} is clearly folded by F_1 folds. Typically, most of the S_{gn} resulted from the flattening and transposition of injected monzogranite sheets and, hence, these gneissic rocks are therefore injection gneiss and not metamorphic gneiss; however, in the central part of the map area, where the rocks are most intensely deformed, rocks of the 'mixed unit' (unit 4) are characterized by metamorphic gneissic layering (S_{gn} distinct from injection gneissosity). This gneissic layering is generally thinner and less regular than that derived by the injection of monzogranite sheets. Nevertheless, both types of gneissosity are parallel.

G_1 structures

F_1 folding

An early generation of folds (F_1) has been noted at a number of localities (Fig. 4B), particularly where the S_{gn} is subhorizontal. Where the S_{gn} is moderate to steep, F_1 folds are difficult to distinguish from later F_2 folds. F_1 folds are recumbent and tight to isoclinal, with axial planes that strike approximately east-west and dip shallowly to the north (present-day co-ordinates: Fig. 4B). Owing to the limited number of F_1 folds observed, the geometry of the F_1 fold belt prior to G_2 is uncertain. The authors suggest, however, that F_1 folds were likely shallowly west-plunging with subhorizontal axial surfaces prior to G_2 (*see* below).

S_1 foliation

The S_1 foliation, defined by aligned biotite and/or hornblende and flattened, elongate quartz and plagioclase grains, is almost always parallel to the S_{gn}, but is rarely observed to be axial planar to the recumbent F_1 folds. S_1 is folded by F_2 folds or transposed into the S_2 foliation (Fig. 4C), and, on a stereonet

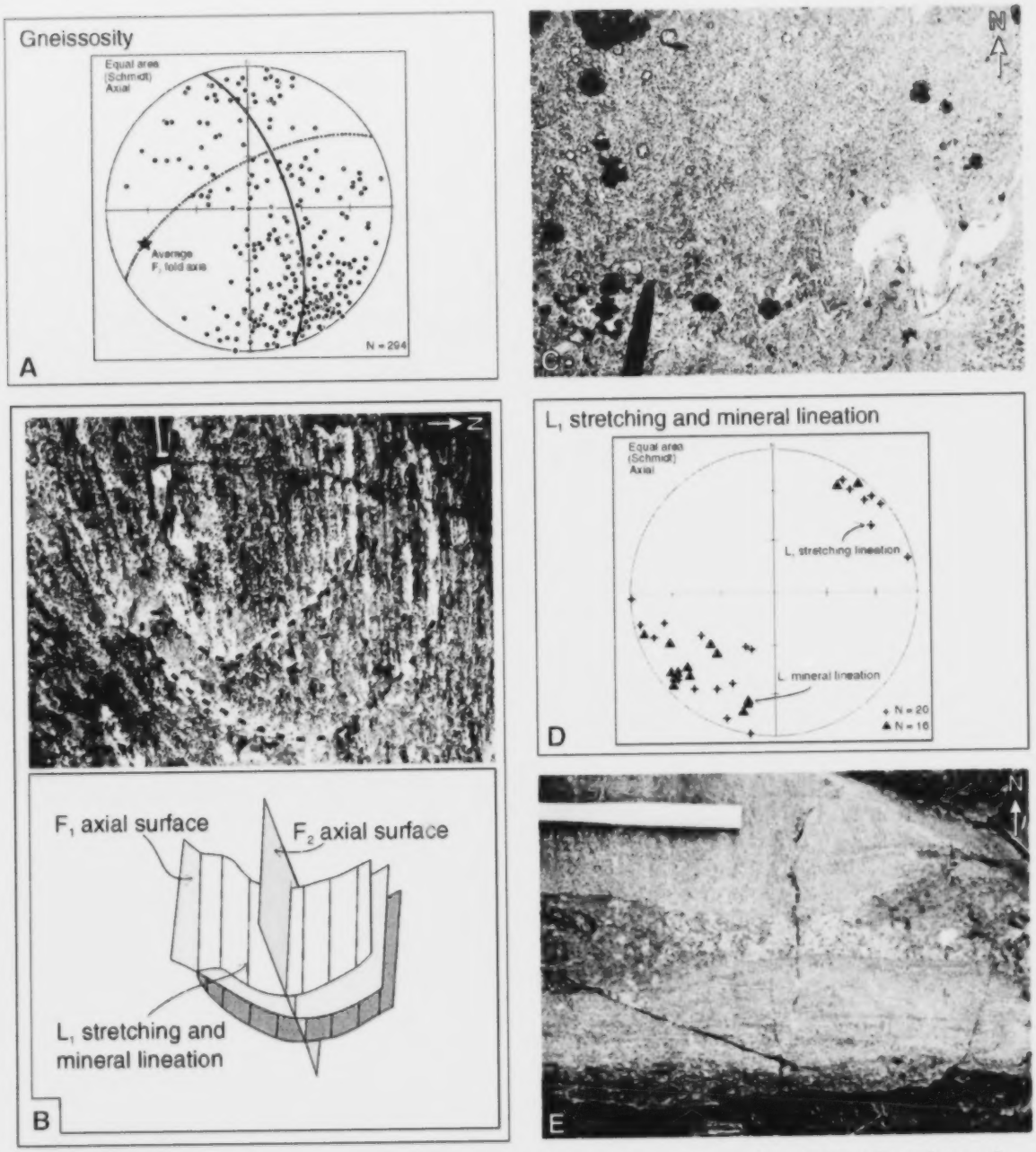

Figure 4. *Pre-G_1 and G_1 structural elements.* ***A)*** *Stereonet projection of the poles to gneissosity (S_{gn}). The red star indicates the average F_2 fold axis.* ***B)*** *Refolded F_1 fold (outlined by the red dashed line) with an L_1 stretching lineation parallel to the fold axis (sketched underneath for clarity) in unit 4; portion of marker shown is 3 cm.* ***C)*** *S_1 foliation folded and transposed parallel to S_2 in unit 5; portion of pencil shown is 3 cm.* ***D)*** *Stereonet projection of L_1 stretching and mineral lineations.* ***E)*** *Hornblendite layer boudinaged parallel to the subhorizontal lineation in unit 4; length of hammer handle showing is 26 cm.*

projection, exhibits a pattern of pole to plane distribution comparable to the S_{gn} (Fig. 4A). The S_1 foliation is therefore interpreted as a composite bedding-S_{gn}-S_1 fabric.

L_1 structural elements

Stretching (L_{1s}) and mineral (L_{1m}) lineations are well developed in the central-eastern part of the map area within a region characterized by a shallowly plunging, regional-scale fold hinge. The L_{1m} defined by hornblende is best developed in hornblende diorite (unit 5) and quartz gabbro (unit 6), where it plunges both to the east and west (Fig. 4D). The L_{1s} is best developed in gneissic tonalite (units 4 and 7) and is defined by extended quartz, plagioclase, and quartzofeldspathic segregations (?melt; Fig. 4B). L_{1s} and L_{1m} are subparallel and are themselves subparallel to F_2 fold axes (Fig. 4D). The lineations are interpreted to have developed during G_1 and were subsequently rotated into colinearity with the F_2 fold axes. Competent layers such as hornblendite are locally boudinaged parallel to the subhorizontal lineation (Fig. 4E). These structures indicate an important component of extension during G_1.

G_2 structures

F_2 folds

Stereonet data demonstrates that S_{gn} is folded about F_2, defining shallowly southwest-plunging folds (Fig. 4A); however, macroscopic folds are noted to plunge both to the southwest and northeast (Fig. 5A). F_2 folds are tight, and shallowly to moderately northeast- and southwest-plunging, with axial surfaces generally steeply dipping to the north (Fig. 5B). The doubly plunging nature of the F_2 folds is interpreted to reflect the reorientation of F_1 folds, and not later cross folding. Mesoscopic F_2 fold traces were determined from S_2 and S_{gn} overprinting relationships (clockwise or counterclockwise), parasitic fold asymmetry (Z, S, and M folds), and through tracing lithological contacts. The massive sulphide interval is demonstrably folded by F_2 folds (Fig. 5C).

S_2 fabric

S_2 foliations, typically defined by aligned biotite and hornblende, are not widely developed. Where observed they most commonly parallel S_{gn} and S_1 foliations and therefore represent a composite S_1/S_2 fabric. S_2 is also observed to have

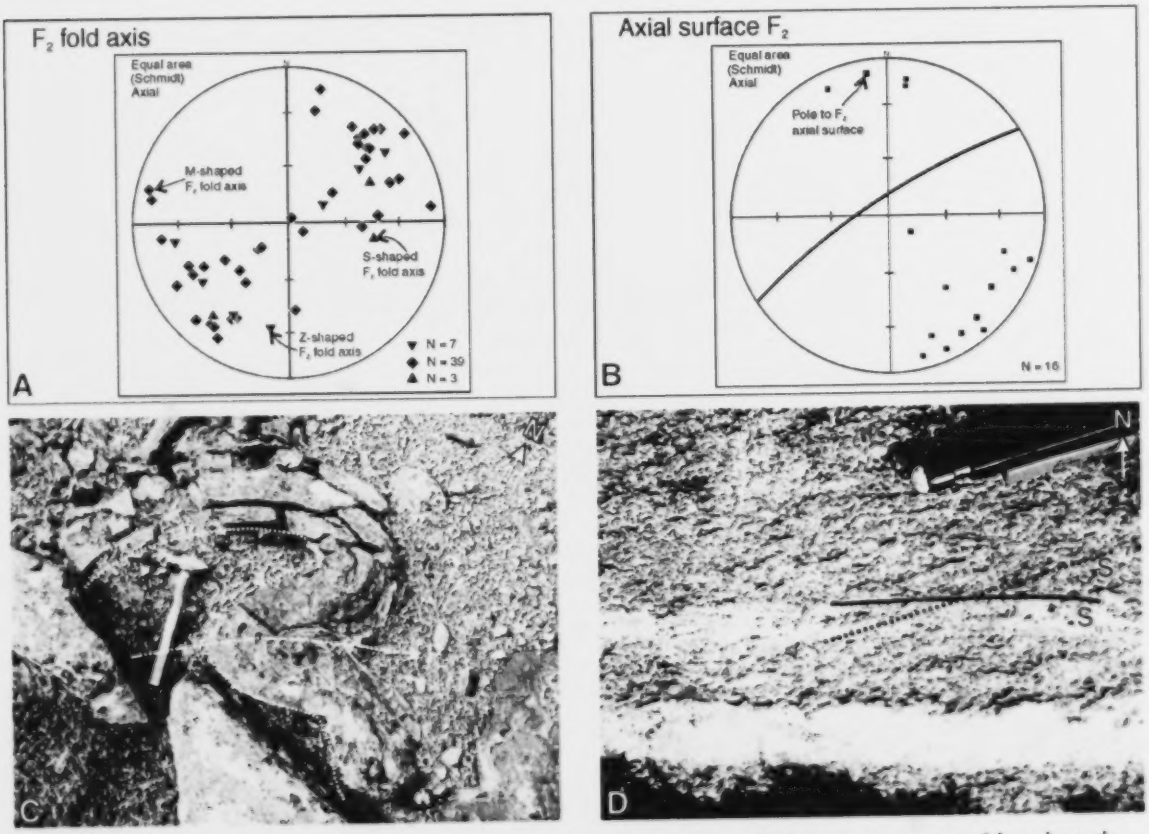

Figure 5. *G_2 structural elements. **A)** Stereonet projection of the F_2 fold hinges. **B)** Stereonet projection of the poles to the F_2 axial planes. **C)** F_2 fold of the massive sulphide horizon in unit 4; length of hammer is 38 cm. **D)** S_2 foliation oriented counterclockwise to the gneissosity (S_{gn}) in unit 4; portion of pencil shown is 3 cm.*

developed at a low angle to G_1 fabrics in the hinge zones of F_2 folds (Fig. 5D). At localities where the rocks are foliated, but not gneissic (e.g. quartz gabbro: unit 6), it is difficult to assign a generation to the foliation (i.e. S_1 versus S_2).

Post-G_2 structures

F_3 folding

A third generation of folds (M. Henderson, unpub. report, 1999; L. Gal, unpub. internal memo, Starfield Resources Inc., September 2001) display east-west oriented enveloping surfaces and are steeply plunging to the north or south (dependent on the dip of the stratigraphy prior to G_3). These low-amplitude folds are open and display metre-scale wavelengths. The F_3 event does not significantly affect the geometry of the rocks exposed in the area.

Discrete shear zones

Centimetre- to decimetre-scale, ductile shear zones identified in the map area are best developed in the schistose chloritic selvages of north-south-oriented gabbro dykes and as north-northeast-trending zones in gabbroic intrusions. Shear bands in the chloritic zones suggest sinistral displacement. Shear zones having a dextral sense of displacement are less common, are similar to the sinistral shear zones, but typically trend east-northeast. Collectively, these discrete ductile shear zones likely represent a conjugate set indicating northwest-southeast compression (sigma 1).

Brittle faulting

Major northwest-trending dextral faults and east-trending faults with unknown sense of displacement (Fig. 1), are characterized by wide (up to 50 m) cataclastic zones and have been identified in the field and in drill core (e.g. Starfield Resources Inc., DDH-FL00-31). The cataclasites exhibit strong feldspathic alteration with chlorite, epidote, and less common carbonate alteration. Some faults are inferred on the basis of prominent aerial photograph lineaments and by inferred stratigraphic discontinuity.

STRUCTURAL MODEL AND CORRELATION WITH REGIONAL-SCALE DEFORMATION

The deformation history of a number of discrete areas in the vicinity of Ferguson Lake in the Hearne Domain have been previously documented by Relf et al. (1997, 1998, 1999) in the Yathkyed greenstone belt; by Ryan et al. (1999) in the Gibson Lake–Cross Bay–MacQuoid Lake area; and by Bell (1971) and Eade (1986) in the vicinity of Henik and Ferguson lakes. Although it is challenging to make regional-scale correlations based on the characteristics and orientations of fabrics and folds, the present authors attempt, nevertheless, to correlate the deformational features observed in the Ferguson Lake study area with those documented by Eade (1986) and by Relf et al. (1997, 1998, 1999).

G_1

The G_1 tectonothermal event produced regional-scale, amphibolite-grade metamorphism and F_1 folding with the development of an associated S_1 foliation and L_{1s} and L_{1m} lineations. The gneissic layering (S_{gn}) may have developed during an early stage of G_1, but it more likely developed pre-G_1. F_1 folds are recumbent with axial planes dipping shallowly to the north, and are interpreted to have developed as a result of north-over-south thrusting with an east-west maximum extension component coaxial with L_1 lineations.

Relf et al. (1998) documented an early southeast-directed reverse thrust event along the Tyrrell shear zone (a northeast-trending Archean structure in the Yathkyed greenstone belt) possibly contemporaneous with a bedding-parallel foliation. This deformation is interpreted to have resulted from regional shortening and has been dated at ca. 2.62 Ga (K. MacLachlan, pers. comm., 1998). G_1 deformation in the Ferguson Lake area is possibly correlative with the early thrusting documented by Relf et al. (1998).

G_2

The G_2 event produced large-scale, doubly-plunging folds with northeast-striking axial planes, likely developed as a result of northwest-southeast oriented compression. The map-scale fold pattern is complex, plunging both to the northeast and southwest, and inferred to reflect the interference of F_1 folds. The block diagrams in Figure 6 portray the post G_2-geometry of the region (present-day configuration), but excludes the effects of subsequent F_3 folding and ductile-brittle faulting.

F_2 folding in the Yathkyed greenstone belt, exposed immediately to the south (Relf et al., 1997, 1998, 1999) shares similar characteristics and kinematics with G_2 in the Ferguson Lake area. To the south, S_2 foliation development and peak metamorphism have been dated at ca. 2.55–2.50 Ga (K. MacLachlan, pers. comm., 1998). The F_2 folding at Ferguson Lake is correlative with the first regional-scale folding event of Eade (1986).

G_3

The G_3 event produced open, low-amplitude, nearly upright folds resulting from east-west compression. Although they were noted throughout the map area, these folds did not affect the overall geometry and disposition of the rocks.

F_2 folds described by Eade (1986) as broad, open flexures are inferred to correlate with the F_3 folds at Ferguson Lake although the orientations of the fold axes are distinct. This difference may be explained by variation in the orientation of pre-existing structures. F_3 folds with large wavelength are also documented in the Yathkyed greenstone belt (Relf et al., 1999), but no timing constraints are currently available.

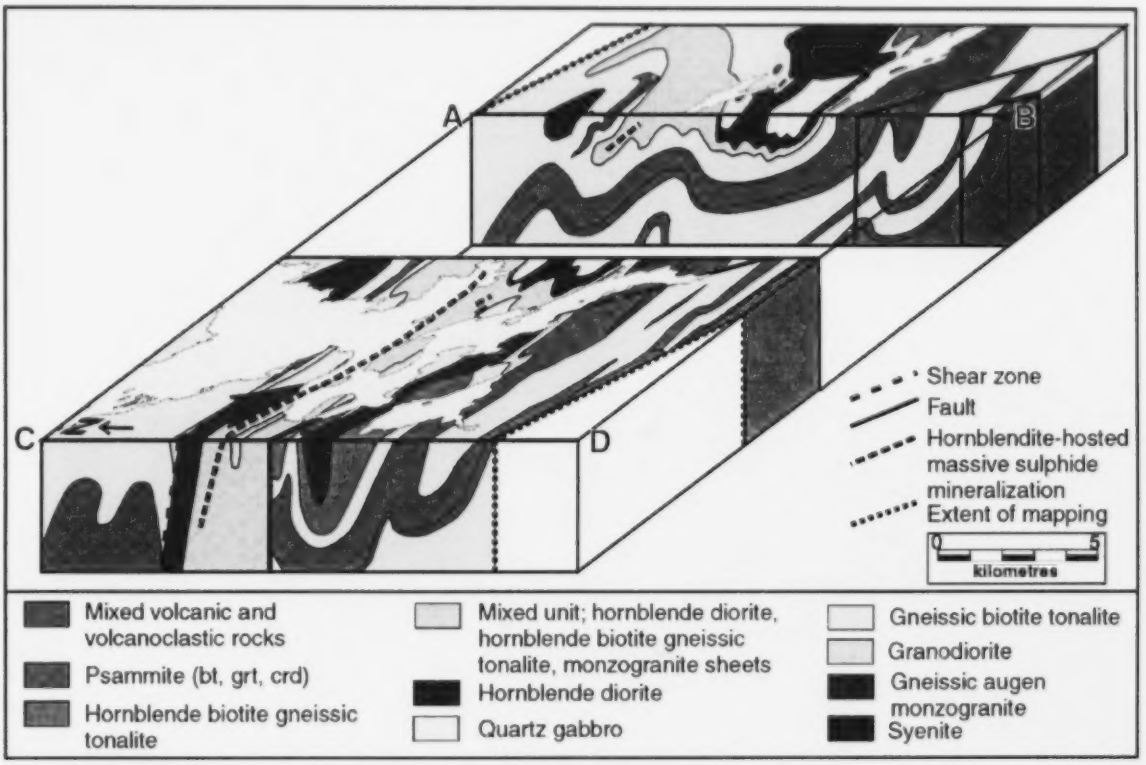

Figure 6. *Block diagrams showing the present-day geometry of the rocks exposed in the Ferguson Lake area. Locations of cross-sections are shown in Figure 1.*

Shearing

East-northeast- and north-northeast-oriented discrete shear zones define a conjugate set and indicate a maximum compression component oriented approximately northwest-southeast. This shearing is late in the geological history, occurring after the intrusion of the gabbro dykes correlated with the Tulemalu swarm.

In the Yathkyed greenstone belt, normal dextral shearing along the Tyrrell shear zone was constrained to have occurred at ca. 1.82 Ga (K. MacLachlan, pers. comm., 1998). The development of the discrete shear zones in the Ferguson Lake area may be correlative with this Proterozoic event.

Brittle faulting

Brittle faults transect all of the map units. Northwest-trending faults commonly show an apparent dextral displacement, whereas east-trending faults have an unknown sense of displacement.

Northwest-trending, brittle faults having a dextral sense of displacement were documented in the Yathkyed greenstone belt and environs by Relf et al. (1999) and Eade (1986). The latter author also documented a number of east-west faults characterized by south-side-down movement. One of these faults is likely a continuation of the east-west fault mapped in this investigation (labelled 'Fc' on Fig. 1).

IMPLICATIONS FOR TIMING OF MINERALIZATION

The Ferguson Lake Ni-Cu-PGE ore zone is hosted by hornblendite. The hornblendite shows gradational contacts with hornblende diorite and hornblende-biotite tonalite. As there are no distinct breaks within this sequence the hornblendite is interpreted to be part of a multiphase or differentiated mafic intrusion that collectively forms unit 4. The massive sulphide mineralization is spatially associated with the hornblendite interval and likely represents an accumulation of magmatic sulphide minerals. The lithologies that host the massive sulphide interval are located on the north-dipping limb of a regional F_2 fold. The hornblendite records an early foliation (S_1) and both the massive sulphide and hornblendite intervals are folded by F_2 and F_3 folds (Fig. 5C, 6). This indicates that the hornblendite and the contained massive sulphide have seen all of the deformation events recognized in the Ferguson Lake area. Because the G_1 and G_2 events are tentatively correlated with the 2.62 Ga thrusting and 2.55 Ga folding and metamorphism recorded in the Yathkyed greenstone belt (Relf et al. (1999) and references therein), and assuming that

the interpretation of unit 4 (host to mineralization) being intrusive in origin are correct, the mineralization is inferred to have formed from an Archean multiphase or differentiated mafic intrusion that was intruded into a supracrustal sequence.

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